Alternative: Manage Well Field / Install New Municipal/ Industry Supply Wells and/or Domestic Supply Wells

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1. Summary of the Alternative

Meeting water supply demands in the future will require sound management of existing well fields and possibly the installation of additional well fields. This white paper combines the discussion of both expansion and management issues faced in the Jemez y Sangre region:

- Well field management, including optimizing the number, sizes, depths, pumping rates, and locations of municipal/industrial water supply wells.

- Installation of new municipal/industry supply wells and/or domestic supply wells, including:
  - Acquiring water rights and installing more municipal/industrial water supply wells
  - Installing new individual domestic water supply wells
  - Creating new mutual/community water systems
  - Improving existing mutual/community water systems.

Issues associated with these options include investigating hydrologic conditions and obtaining land and financing for well construction.

For this discussion, a well field refers to any group of wells, municipal or domestic, producing from the same aquifer. Generally, a well field is designed to meet immediate and projected needs over several decades, roughly corresponding to the expected life of a well. Expansion of a well field to increase yield requires the proper hydrologic conditions and available water rights.

All of the large municipalities in the Jemez y Sangre planning region rely on local groundwater resources for at least a portion of their water supply (DE&S, 2001). The City of Santa Fe has the Buckman and City of Santa Fe well fields. Los Alamos uses several well fields including Los Alamos, Guaje, Pajarito Mesa, and Otowi. Española and small communities such as El Dorado also have well fields. In addition to the municipal well fields, numerous domestic wells throughout the planning region supply single or sometimes multiple homes. Community and mutual domestic water associations also play an important role in supplying rural homes throughout the region.

The hydrologic conditions in the Jemez y Sangre region are favorable to expansion of existing well fields to increase supply. The region lies mostly in the Española Basin, which corresponds to the Española structural geologic basin described by Kelley (1978). This basin consists of the Rio Grande and Rio Chama valleys and is bounded by the Jemez Mountains to the west and Sangre de Cristo Mountains to the east. The main water-bearing unit or aquifer consists of sand and gravel units deposited along the river valleys throughout geologic history and are collectively termed the Santa Fe Group. Hydrogeologic characteristics vary within the Santa Fe Group and throughout the region, but overall, the Santa Fe Group yields fairly high quantities of good-quality water to wells.

Availability of water rights in the Jemez y Sangre planning region will be the primary controlling factor in the expansion of well fields. The subtleties of water rights in the region are beyond the scope of this discussion, but parties attempting to acquire water rights should be aware of the following entities that influence control of water rights and overall availability of water in the region:

- The Office of the State Engineer (OSE) administers New Mexico water law.

- Traditional entities such as acequias have a very active role in local water use.

- Several Pueblos are located within the planning region, and their water rights are reserved under federal law and will play a major role in the future water use of the area.

- The federal government maintains water rights for public lands such as U.S. Forest Service or Bureau of Land Management holdings.

The presence of substantial volumes of water in the aquifer units that underlie the planning region does not necessarily ease the water rights issue. Although the consequences may not become evident for many years, extraction of the water from the aquifer units will eventually cause reductions in streamflows of the Rio Grande and its tributaries. Because of this effect on the Rio Grande, which is a fully appropriated stream system, water rights that offset the expected amount of streamflow depletion must be obtained before any new pumping at existing or expanded well fields will be permitted by the OSE. This constraint currently applies to all municipal, industrial and agricultural users; it does not currently apply to domestic wells, although that condition will likely change in the near future (Section 4).

Of the options discussed in this white paper, the installation of domestic wells is the only one that could actually increase the supply available to the region without purchasing water rights (although this gain may be short-term if the new domestic wells impair senior water rights). The other options focus on better management of well fields to increase sustainability and reduce vulnerability during a drought. Installing more municipal wells can increase the supply, but water rights are required for this option. The potential gain from such an action is considered under the alternative Purchase Water Rights (DBS&A, 2002a).

2. Technical Feasibility

The prime benefit of expanding well fields or increasing the number of domestic supply wells is the acquisition of additional water. Within the Jemez y Sangre planning region, land and substantial amounts of good quality groundwater are generally available to expand existing well fields or to create new ones. However, the groundwater supply is not infinite and groundwater mining has already begun in several of the sub-basins due to pumping for municipal supply (DE&S, 2001). In addition, some areas, such as the South Galisteo Sub-basin, have fairly limited groundwater availability. An up-to-date numerical model would greatly assist with the determination of the technical feasibility and long-term implications of installing new wells.

Given the acquisition of the necessary water rights, the installation of new wells is readily accomplished and involves the following steps:

- Evaluating the hydrogeologic conditions
- Determining appropriate well spacings to avoid excessive pumping interference
- Designing the new wells
- Constructing the wells
- Performing well yield and water quality testing
- Connecting the well(s) to conveyance systems for distribution

These steps are discussed in further detail in Sections 2.1 through 2.5.

2.1 Hydrogeologic Conditions

The Santa Fe Group within the Española Basin has a very substantial, but not unlimited, quantity of groundwater in storage (DBS&A, 1994). Due to relatively small recharge rates that occur within the planning region (less than 1 inch per year), the groundwater resource is essentially non-renewable, and depletions to the aquifer caused by mining groundwater from storage (pumping water at a greater rate than it is recharged) should be carefully planned to achieve maximum benefit.

DE&S (2001) presents estimated groundwater budgets for each basin in the planning region based on estimated inflows and outflows to the groundwater systems. Their calculations indicate that for most of the basins inflows approximately equal the outflows and the groundwater system appears to be in a state of equilibrium (i.e., mining is not occurring). In only two of the basins, the Los Alamos and Caja del Rio basins, did their estimated overall outflows exceed inflows, indicating that groundwater within those basins is being mined, apparently due to the Los Alamos and Buckman well fields, respectively (DE&S, 2001). The calculations conducted by DE&S are only approximate, however, and anecdotal evidence such as apparent reduction in spring flows may indicate that more widespread groundwater mining has occurred over the past 20 years.

Water level declines in the vicinity of the wells fields also indicate that the resource is being mined in these locations. These localized declines can result in aquifer compaction and loss of storage capacity in the aquifer, and the reduction in storage capacity results in a permanent decline in yield from the well field. With better management of the well field, water level declines could be reduced, thus preventing such degradation. However, legal constraints in the water rights system do not generally allow for such flexibility.

2.2 Well Field Design

Well field design involves the determination of effective well spacing to create cost-effective pumping and conveyance systems. The same design considerations apply to municipal and domestic wells, although efficient design is generally more critical for municipal wells due to their larger pumping rates. Determination of appropriate well spacing is primarily dependent upon the transmissivity and storage coefficient of the aquifer and the locations, pumping rates, and depths of the wells.

Hantush (1964) discusses well field design in terms of interference between pumping wells. When a well pumps water from an aquifer such as the Santa Fe Group, the aquifer material near the well is dewatered (or depressured) and a cone of depression forms around the well. Well interference occurs when the cones of depression caused by multiple wells overlap one another. This condition results in additional drawdown in the wells as compared to the case where only one well (with its own cone of depression) is present.

The disadvantage of well interference is the additional pumping capacity needed to overcome the increased lowering of water levels caused by the interference. Wells should be spaced far enough apart so that the effects of interference are minimal; however, if the wells are too far apart, conveyance and pumping system costs may be prohibitive. In practice, a certain amount of interference is usually accepted to maintain reasonable short-term costs for infrastructure.

To address this issue, the OSE has promulgated aquifer management criteria for various groundwater basins in the state within which the groundwater is being mined (e.g., the Mimbres and Lordsburg Basins). These basins are administered based on a grid system in which pumping is restricted based on allowable rates of drawdown in the aquifer, a condition that imposes minimum spacings between production wells dependent upon pumping rates and aquifer characteristics. The OSE has not promulgated an aquifer management rule in the planning area. However, Santa Fe County through its Land Development Code effectively regulates the spacing of domestic wells through minimum lot sizes and requirements on water availability beneath the lots. The primary groundwater users in the planning region, the public water systems, do not have any aquifer management rules or guidelines.

An additional benefit of efficient well field design is that it will minimize, through causing smaller drawdowns over larger regions, aquifer compaction and associated reduction in well capacity. If significant drawdowns persist sufficiently long, land subsidence and earth fissures are likely to occur.

2.3 Well Design and Construction

Well construction will be needed both for replacing older wells removed from service and for development of new well fields. Design of supply wells should follow the procedures and standards presented by the U.S. Environmental Protection Agency (EPA) (1975) and the American Water Works Association (AWWA) (1997). Roscoe Moss Company (1990) and Driscoll (1986) also present standard practices of well design and construction.

Hydrogeologists and engineers keep several goals in mind while designing supply wells (Driscoll, 1986). Will the well produce a maximum amount of water with a minimum amount of drawdown within the given aquifer? What is the water quality at the well field? Will the well design and selected well materials produce sand-free water? Will the well have a long life of 25 years or even more? Are the costs within reason in the short and long term? These questions apply both to individual wells and to well fields as a whole.

2.4 Well Testing

When a well is installed, yield and water quality tests are performed. Well yield is determined through a series of pumping tests over a given amount of time. The data collected are used to calculate pumping rates and project drawdown in the well and in the surrounding aquifer. These calculations are also used to determine well interference within the well field.

Water quality testing must be completed before the water is distributed to consumers. Expansion of domestic well fields may raise water quality issues in areas where septic tanks are relied on for domestic wastewater treatment. According to DE&S (2001), water quality in the planning region is generally very good to excellent. Total dissolved solids (TDS), nitrate, and fluoride in groundwater may be of concern in local areas but they are not a major large-scale concern. Uranium concentrations are naturally elevated in the Pojoaque Valley (DE&S, 2001), and a new arsenic standard by the EPA is exceeded in many locations in the planning region (DBS&A, 2002b).

2.5 Water Distribution

Water distribution consists of conveyance systems to deliver water from the point of diversion (wells) to treatment facilities, if needed, and then to the consumer. Generally conveyance infrastructure includes (1) the pumping system in the well or pump station to pressurize the water and deliver it to the storage tanks and (2) the conveyance system that transports the stored water to users. Treatment, if needed, usually includes disinfection by chlorination or may include filtering to remove unwanted constituents such as dissolved solids, arsenic, sulfate or uranium.

2.6 Well Field Management

As municipalities expand their well fields, their existing water departments would expand their management duties to include the new well field. No such management capability generally exists for domestic wells. Yet as domestic wells increase in number, especially when considering the potential population increases in the planning region, problems may develop such as excessive well interference and localized drawdown or the drying up of older, shallower wells. Some form of collective management would greatly assist in avoiding, or at least minimizing, these issues.

One alternative to individual homeowners drilling their own wells is the formation of community or mutual domestic water associations for small water systems that serve 3,300 households or less. The New Mexico Environment Department defines a community water system as a "public water supply system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents" (20 NMAC 7.1). Due to the rural nature of the many parts of the Jemez y Sangre planning region, small community water systems will be critical to managing water resources. One added benefit of this approach is that water use can be more easily quantified (e.g., metered), which will lead to more accurate data for long-range planning decisions.

3. Financial Feasibility

Increasing infrastructure is fairly straightforward, and financing is available for municipalities and community water associations through, for example, the Community Development Block Grants and the New Mexico Finance Authority. Another option is to pass the costs on to the consumer. Domestic well owners must seek their own financing to pay for a new well.

The magnitude of water well costs varies with the quantity of water that the owner expects to pump from their well. Municipalities in the planning area need relatively deep wells capable of producing 500 to 600 gallons per minute (gpm). A large municipal well requires the services of an experienced hydrologist or engineer capable of designing, overseeing construction of, and testing the new well. The hydrologist assists the municipality in selecting an experienced driller, provides contract administration, and oversees the construction activities. The costs presented in Table 1a include drilling and consulting services for municipal supply wells. A community well should yield between 50 and 150 gpm and will not need to be as deep as a municipal well. A community would benefit from the services of an experienced hydrologist or engineer for well design and construction oversight. A local driller may also provide insight for well design based on their experience in the area. Costs for community wells are shown in Table 1b, including estimates for submersible pumps and a modest well house.

Domestic wells are generally designed and installed by a local well driller. Most domestic wells are intended to produce less than 50 gpm. Table 1c presents estimated costs for installation of domestic supply wells in the Jemez y Sangre region.

Table 1a. Cost Estimate for Construction of Municipal Water Supply Wells in the Alluvial Valley Jemez y Sangre Water Planning Region

Item	Unit	Unit Cost ($)	Quantity	Total ($)
Well Installation				
Mobilization	Lump sum	90,000	1	90,000
Drill pilot hole, 8-inch	Linear feet	45	1,260	56,700
Geophysical logs (electric logs)	Lump sum	9,500	1	9,500
Ream pilot hole for surface casing, 30-inch	Feet	125	80	10,000
Conductor casing, 30-inch installed	Feet	140	80	11,200
Ream pilot hole, 26-inch	Feet	50	1,180	59,000
Blank casing, 16-inch, in place	Feet	65	420	27,300
Casing, perforated, 16-inch, in place	Feet	100	840	84,000
Gravel feed line, in place	Feet	8	390	3,120
Gauge line, in place	Feet	6	620	3,720
Gravel, in place	Cubic yard	300	80	24,000
Cement annular seal, in place	Cubic yard	220	76	16,720
Development by zoned air-lift pumping and swabbing	Hour	225	72	16,200
Furnish, install and remove test pump	Lump sum	17,500	1	17,500
Development and test pumping	Hour	175	100	17,500
Video survey	Lump sum	1,500	1	1,500
Disinfection	Each	500	1	500
Water quality testing	Lump sum	2,000	1	2,000
Design and oversight [a]	Lump sum	57,500	1	57,500
Well installation subtotal				*507,960*
Well House and Pumping Equipment				
Pumping equipment and controls, installed	Lump sum	145,000-200,000	1	145,000-200,000
Disinfection equipment, installed	Lump sum	40,000	1	40,000
Piping and valves, installed	Lump sum	35,000	1	35,000
Well house with climate control	Square foot	100	625	62,500
Well house foundation	Square foot	15	625	9,375
Utilities (electrical and alternative power supply)	Lump sum	25,000-100,000	1	25,000-100,000
Site fencing	Lump sum	7,500	1	7,500
Grading and drainage	Lump sum	12,500	1	12,500
Energy dissipater	Lump sum	25,000	1	25,000
Engineering design, specifications, and oversight	Lump sum	40,000	1	40,000
Well house and pumping equipment subtotal				*401,875-531,875*
Grand total				**909,835-1,039,835**

[a] Design and oversight includes well design, permitting, geological logging, and construction oversight.

**Table 1b. Cost Estimate for Construction of Community Wells
Jemez y Sangre Water Planning Region**

Item Description	Unit	Estimated Quantity	Unit Price ($)	Amount ($)
Mobilization and demobilization	Lump sum	1	15,000	15,000
Drill 7 7/8-inch hole	Linear feet	385	30	11,550
Geophysical logging	Lump sum	1	3,500	3,500
Casing, blank, 6 5/8-inch, Roscoe Moss, in place	Linear feet	320	6	1,984
Casing, perforated, 6 5/8-inch, 0.188-inch wall, in place	Linear feet	60	37	2,205
Cement annular seal, in place	Linear feet	80	9	720
Development, air lift	Hours	8	180	1,440
Well disinfection	Lump sum	1	750	750
Goulds 70J10, 10-HP pump and motor	Lump sum	1	3,240	3,240
Install pump	Lump sum	1	1,500	1,500
Column pipe for pump, 3-inch, low carbon steel, galvanized	Linear feet	300	6	1,938
Pitless adaptor, spool type	Lump sum	1	600	600
Pump panel/starter box, single phase	Lump sum	1	670	670
Pressure tank, 119-gallon	Lump sum	2	800	1,600
Development and test pumping	Hours	30	85	2,550
Water quality testing	Lump sum	1	1,500	1,500
Well house	Lump sum	1	4,000	4,000
Well house pad	Lump sum	1	2,000	2,000
Total				56,747

**Table 1c. Cost Estimate for Construction of Domestic Wells
Jemez y Sangre Water Planning Region**

Item Description	Unit	Estimated Quantity	Unit Price ($)	Amount ($)
Well Installation: 8-inch boring, 6-inch PVC well, total depth of 350 feet [a]	Lump sum	1	5,250	5,250
Submersible pump: 3-HP pump and motor, installed	Lump sum	1	1,600	1,600
Pitless adaptor, spool type	Lump sum	1	600	600
Pump panel/starter box, single phase	Lump sum	1	670	670
Pressure tank, 119-gallon	Lump sum	1	800	800
Water quality testing	Lump sum	1	200	200
Total				9,120

[a] Well installation includes mobilization, drilling, casing, screen, annular seal, gravel pack, and development.

4. Legal Feasibility

Changes in the number, sizes, depths, pumping rates and locations of wells serving municipal and industrial purposes require approval of the OSE. State law allows "The owner of a water right may change the location of his well or change the use of the water, but only upon application to the state engineer and upon showing that the change will not impair existing rights and will not be contrary to the conservation of water within the state and will not be detrimental to the public welfare of the state." (NMSA 1978, §72-12-7(A)). As long as the change does not result in increased total pumping, then the primary legal obstacle will be assuring that the change does not cause localized well interference or increase surface depletions by a change in the location of a well field pumping center or by timing of uses.

New groundwater points of diversion can be permitted as municipal wells or as domestic wells. In this context and with regard to municipal systems, one option being considered by the region is acquiring water rights and installing new municipal supply wells. The acquisition of water rights in a basin where all surface water effects of groundwater pumping must be offset can only occur through the marketplace between a willing seller and a willing buyer. Generally, the State Engineer only allows the transfer of perfected consumptive water rights. Such transfer can only occur after publication and notice and after a determination that the new point of diversion and place and purpose of use will not impair existing water rights, will not be contrary to the conservation of water, and will not be detrimental to the public welfare. The continued perfection of a municipal water permit may be limited to a 40-year well. For example, the City of Santa Fe has been limited in its ability to perfect its permitted water rights.

The issue of the continued viability of domestic wells is currently in a state of flux, based on the State Engineer's plan to propose legislation in the 2003 legislative session to greatly curtail the right to appropriate water for domestic purposes. The proposed legislation would give the State Engineer new authority in areas where domestic wells affect the State's ability to meet delivery obligations to Texas. Under the proposed legislation, the State Engineer would be allowed to turn down new permits, limit the amount of water pumped, and require metering.

Although this discussion focuses on the current state of the law for domestic wells, all participants in the region's planning process must be aware of the potential for major changes in this area. One important note, though, is that if domestic wells are prohibited or severely limited in the future, such a prohibition may be most compelling in the adjudication context. Several of the tributaries in the planning region are subjects of stream system adjudication suits. Once these cases are complete, it is likely that the Court will appoint a water master to oversee the administration of priorities. In instances where recent junior domestic wells are depleting surface flows, the water master and/or the Court may regulate or could prohibit the use of such wells if their use interferes with the exercise of senior water rights. There are very old Pueblo and acequia water rights which would have first priority in these tributary basins. Where existing rights afford little or no room for additional withdrawals from an aquifer, persons in need of domestic water may have to purchase water rights to transfer to their property or tie into a community system.

Under the New Mexico Water Code, an applicant may receive a domestic well permit to appropriate up to 3 acre-feet per annum of water for "household or other domestic use, and in prospecting, mining or construction of public works, highways and roads or drilling operations designed to discover or develop the natural resources of the state." Such a permit may be obtained from the State Engineer without acquiring commensurate groundwater rights or retiring offsetting surface water rights (NMSA 1978, §72-12-1). Historically, the domestic well statute has not given the State Engineer discretion to deny a permit application: "[u]pon the filing of each application . . . the state engineer shall issue a permit." (NMSA 1978, §72-12-1). The State Engineer currently allows interconnection of domestic wells, as long as the total amount taken from the combined wells does not exceed 3 acre-feet per annum.

A significant recent legislative development is the passage by the 2001 legislature of Senate Bill 602, which amended the domestic well statute by providing specific statutory authority for local regulation of domestic wells. Senate Bill 602 provisions require the State Engineer to issue permits ". . . if applications for domestic water use within municipalities conform to all applicable municipal ordinances and an application is made for a municipal permit pursuant to Chapter 3, Article 53 NMSA 1978." Therefore, any new use of domestic water in the region must comply with all applicable municipal ordinances. Further, because several adjudications are underway in the basin, the prospect of court orders regulating domestic well rights should be expected, especially once final decrees are entered and basins are administered by priority. Indeed, in *State of New Mexico v. Aamodt* (adjudication of Pojoaque/Tesuque/Nambe stream system), the Court has already limited new domestic well uses on an interim basis, even before entry of a final decree. Once a final decree is entered, further restrictions could be placed on domestic wells.

Municipalities and counties may regulate water use, including imposition of conservation measures, by assuming responsibility through a utility for supplying water to their residents. Municipalities may exercise their powers of eminent domain to establish or expand water utilities. A municipality may condemn various water supplies, water rights, rights-of-way "or other necessary ownership for the acquisition of water facilities" (§ 3-27-2(A)(1) NMSA 1978 (1995 Repl.)). Counties, like municipalities, may also own utilities. Both the City of Santa Fe and Santa Fe County have used the existence of public water utilities to prohibit drilling of new domestic wells within 200 feet of a utility water line (e.g., City of Santa Fe Ordinance No. 1993-3, adopted January 13, 1999). Recently, well owners filed suit against the City challenging its right to regulate domestic wells.

Under Senate Bill 602 and effective June 15, 2001, municipalities have the power to restrict by ordinance the drilling of new domestic water wells, except for property zoned agricultural land, if the property line of the applicant is within 300 feet of the municipal water distribution lines and the property is located within the exterior boundaries of the municipality. Counties could probably also derive such authority from §4-37-1 NMSA 1978 [1992 Repl.], which states "counties are granted the same powers that are granted municipalities . . . [including those powers] necessary and proper to provide for the safety, preserve the health, promote the prosperity and improve the morals, order, comfort and convenience of any county or its inhabitants." A municipality may not deny a new domestic well permit if the total cost to the applicant of extending the municipal water lines, meter and hookup exceeds the cost of drilling a new well. A municipality declining to authorize a new domestic well must provide domestic water service within 90 days at regular rates. Existing wells are not affected by the law.

The legislation creates a new section of Chapter 3 (Municipalities), Article 53 NMSA 1978, and amends §72-12-1 (groundwater statute) to require the State Engineer to grant a permit for a domestic well within municipal boundaries provided it conforms to all applicable municipal ordinances. The amendment language (underlined) reads "Upon the filing of each application describing the use applied for, the state engineer shall issue a permit to the applicant to so use the waters applied for <u>if applications for domestic water use within municipalities conform to all applicable municipal ordinances and an application is made for a municipal permit pursuant to Chapter 3, Article 53 NMSA 1978."</u> Thus, effective June 15, 2001, all domestic well applications filed with the State Engineer must conform to municipal ordinances governing domestic wells, as well as to the new statute allowing municipalities to prohibit domestic wells near water lines.

Another issue is whether a domestic water right can be aggregated and transferred into a common or central water system. There are many examples in New Mexico of the State Engineer approving transfers of domestic rights into community water systems, such as mutual domestic associations. New Mexico law provides for the formation of mutual domestic water associations (NMSA 1978, §§ 53-4-3 and 43-4-1(A)). Mutual domestic water associations are formed through the incorporation of any five or more individuals or two or more associations (NMSA 1978, §§53-4-2). However, because the OSE has at various times stated reservations about this practice and has not established formal procedures governing it, the question arises of the legal basis for this method of creating a community water system.

Neither the domestic well statute nor the New Mexico Constitution contains any language limiting the transferability of domestic water. A water right is a real property right (e.g., *New Mexico Prods. Co. v. New Mexico Power Co.,* 42 N.M. 311, 77 P.2d 634 (1937) ["A water right is property and held to be real property by most authorities."]). Further, there is no language in the water transfer statute that would somehow distinguish a domestic water right as a type of water right that cannot be transferred.

Transfers of groundwater rights are governed by NMSA 1978, §72-12-7. Pursuant to this statute, the owner of a water right may change the location of a well or change the use of water, but only upon application to the State Engineer and upon showing that the change will not impair existing water rights, will not be contrary to the conservation of water within the state, and will not be detrimental to the public welfare of the state. In reviewing an application to transfer domestic well rights into a community system, the State Engineer will require a showing that the proposed transfer will not result in increased withdrawals from the stream system. In other words, the current statutory exemption provided by §72-12-1 may not be used to create a water rights loophole community-wide. The problem can be solved by limiting transfers to the perfected amount of the domestic well and, after the transfer, disallowing further perfection of domestic rights in the same well.

Currently, there is a limited market for the purchase of domestic water rights, since anyone can obtain one through a permit application. But if the State Engineer or a court were to prohibit new domestic wells in fully appropriated basins or limit the amount of water that can be used pursuant to a domestic well permit, a more active market for domestic water might develop.

Another option being explored in the region is improving existing mutual/community water systems. There are no significant legal obstacles which would limit the ability to improve existing systems.

5. Effectiveness in Either Increasing the Available Supply or Reducing the Projected Demand

Additional groundwater supplies can be obtained from most of the sub-basins in the planning region for a significant, albeit finite, period of time. Table 2 provides population, groundwater inflows and outflows, net groundwater use (groundwater pumping minus return flow), and groundwater in storage for the sub-basins in the planning region. Available volumes of groundwater in storage are clearly enormous compared to existing uses, but as discussed in Sections 2 and 4, this water cannot be pumped without obtaining water rights and offsetting the resulting depletions to the Rio Grande and its tributaries.

16

Table 2. Groundwater Budget by Sub-Basin
Jemez y Sangre Water Planning Region

Sub-Basin	Year 2000 Population [a]	Inflow [a] (ac-ft/yr)	Outflow [a] (ac-ft/yr)	Change in Storage [a] (ac-ft/yr)	Net Groundwater Use [a,b] (ac-ft/yr)	Groundwater in Storage in Top 1,000 Feet of Sediment (ac-ft)	Major Well Field in Sub-basin
Velarde	4,870	8,835	8,663	172	278	9,570,000	---
Santa Cruz	19,481	10,650	12,516	–1,866	2,366	5,460,000	---
Santa Clara	4,870	5,120	5,111	9	271	5,430,000	---
Los Alamos	19,481	4,400	6,612	–2,212	3,832	11,020,000	Los Alamos Well Fields
Pojoaque-Nambe	6,494	13,730	14,118	–388	878	3,970,000	---
Tesuque	4,870	8,615	8,944	–329	574	2,930,000	---
Caja del Rio	0	4,700	8,643	–3,943	4993	10,160,000	Buckman Well Field
Santa Fe River	87,666	14,835	12,039	2,796	2094	9,260,000	City Well Field
North Galisteo Creek	11,364	2,580	4,211	–1,631	1,401	0	---
South Galisteo Creek	3,247	6,655	7,225	–570	330	0	---

[a] Source of information: Jemez y Sangre Water Planning Council, 2001.
[b] Groundwater diversions minus return flows.

ac-ft/yr = Acre feet per year
ac-ft = Acre feet

--- = No major well field present in the sub-basin

6. Environmental Implications

As with any construction project, ground will be disturbed. For municipal and domestic wells, the drill rig must have access or easement with enough room for support trucks and equipment. Any projects that include federal funding must conform to the National Environmental Policy Act of 1969 (NEPA) to consider the environmental impacts of the action; such compliance may involve environmental impact statements and endangered species evaluation.

All wells must be sited to avoid contaminated groundwater or surface conditions. The well must be properly constructed to minimize the potential for surface contaminants travelling through the borehole to the water table. The site will need to be located such that the well is protected from flooding, surface contamination, and vandalism.

By lowering the local water table, flows of streams and springs may be reduced or stopped entirely. This condition may cause perennial streams to become ephemeral and local springs to dry up. The implications are not only aesthetic but may impact natural habitat and threatened or endangered species.

7. Socioeconomic Impacts

The drilling of new municipal wells, which would require a transfer of water rights, may cause socioeconomic impacts in the location the water is transferred from. The impacts of water rights transfers are discussed further in another paper (DBS&A, 2002).

Managing well fields to optimize the number, sizes, depths, pumping rates, and locations of municipal/industrial water supply wells would have the socioeconomic benefit of increasing available wet water over the long term. And because such increases would be limited by existing water rights, well field optimization would have no direct significant impact on upstream rural water users and existing water right owners. Using up groundwater supplies would have the indirect impact, however, of increasing the desire for and pressure on upstream rural and agricultural surface water rights to support municipal and industrial needs, once local groundwater supplies are depleted.

Depending on the expense and financing of well field development, the alternative might also have the short-term benefit of reduced water costs for all users. In addition, well field management will help prevent land subsidence and the concomitant damage to buildings and irreversible damage to the aquifer due to the compaction of the aquifer material.

Conversely, installing new domestic supply wells, although increasing available water, would result in greater water use that would diminish groundwater supplies more quickly. Increasing supply through the drilling of domestic wells usurps the water rights process and does not protect senior water rights users in the region. As a result, the long-term socioeconomic and cultural impacts would be contrary to the collective public welfare and contrary to conservation. Socioeconomic and cultural benefits might result from improving existing mutual/community water systems, if those improvements translated into greater efficiency and conservation.

8. Actions Needed to Implement/Ease of Implementation

Management of the aquifer in the region requires a region-wide approach, with input from all stakeholders. With a common understanding of the aquifer conditions—that is, a region-wide model that is supported by all entities—the planning council can better understand the impacts of current stresses on the aquifer and determine better ways to manage the resource. Accordingly, the recommended next steps are:

- Develop a region-wide, ongoing comprehensive groundwater assessment, culminating in a hydrogeologic model for use as a management tool.

- Seek improved and better defined administrative guidelines from the OSE.

- Establish improved planning and zoning guidance at the local (i.e., county) level to incorporate protection of groundwater quality and quantity.

- Evaluate groundwater conditions from a regional perspective that is coordinated around sub-basins.

- Develop an approach to managing new domestic wells in the region.

The steps involved in installing a single new well or expanding a well field are:

- Assess water rights (obtain new ones or alter existing ones)
- Design and site new wells
- Install and construct new wells, including required conveyance systems
- Perform water quality and pump testing

Groundwater modeling may be required to determine optimum locations for new wells.

9. Summary of Advantages and Disadvantages

The advantages of expanding well fields are:

- Relatively quick increase in water supply from new wells
- Proven technology/approach
- Potential shortening of the distance from diversion to user
- Potentially lower operational costs due to more efficient wells
- Potentially increased production through replacement of old wells with better designed wells
- Reduced vulnerability during drought periods
- Inevitable requirement in the future
- Widespread treatment of water quality problems (i.e., removal of naturally occurring arsenic and uranium) through regional well fields

The disadvantages of well field expansion include:

- Increased mining of the aquifer
- Potential water quality problems in expansion areas
- Expense
- The necessity to obtain additional water rights or transfer points of diversion for existing rights
- Potential negative impacts on perennial stream reaches, lowering flow and possibly making them ephemeral
- Additional operation and maintenance costs for greater number of wells
- Interference among wells and lowering of the water table
- Potential land subsidence as aquifer is significantly dewatered
- Potential impairment of senior water rights by large number of domestic wells
- Potential irreversible damage to the aquifer due to lowering of water levels in the aquifer
- Difficulty of removing trace constituents (arsenic and uranium) in individual domestic wells

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